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"birthday book." The mere list of contributions it contains will suffice to show that it is a necessary volume for every botanical library. The topics show a wide range, In physiology Möbius writes on the motor organs of petioles; Westermaier on stomata and their accessory apparatus; Steinbrinck on the hygroscopic mechanism of anthers and plant hairs; Grüss on the action of various enzymes; Kolkwitz on the growth of the chlorophyll bands of Spirogyra; Wille on the migration of inorganic nutritive materials in the Laminariaceæ; Fünfstück on the excretion of fat by calcareous lichens; Reinhardt on plasmolytic studies upon the growth of the cell wall; and Tschirch on the formation of resin.

Under physiological morphology may be enumerated the contributions of Haberlandt on the experimental production of a new organ in *Conocephalus ovatus;* and Heinricher on the regenerative power of the bulblets of Cystopteris. To morphology proper belong the papers of Lindau on the lichen genus Gyrophora; Bitter on the meshlike perforations of the lower tissue or the whole thallus of various foliaceous and fruticose lichens; Weisse on the development of the flower of Onagraceæ, with especial reference to the inferior ovary; Jahn on the myxomycete *Comatricha obtusata;* Schellenberg on the development of the stem of *Aristolochia Sipho;* Kuckuck on the polymorphy of certain Phæosporeæ; and Correns on the apical growth, phyllotaxy, and branch rudiments of moss stems.

Ecological contributions are those by Giesenhagen on adaptive phenomena of certain epiphytic ferns; Schumann on epiphytic cactuses; Volkens on the pollination of certain Loranthaceæ and Proteaceæ by birds; Holterman on termites and fungi; and Marloth on the leaf sheaths of *Watsonia Meriana* as water-absorbing organs.—C. R. B.

NOTES FOR STUDENTS.

PALLA describes a new Phyllactinia[4] (*P. Berberidis*) and points out that the species of this genus do not form haustoria in the epidermis of the host, but send lateral hyphæ through the stomata into the intercellular spaces of the spongy parenchyma. These hyphæ alone form haustoria. In this the genus differs from the rest of the Erysipheæ which have been investigated. —C. R. B.

MR. FRANCIS RAMALEY has been investigating numerous seedlings of woody plants, and two published papers (*Min. Bot. Studies* **2**: 69–136. 1899) contain some of the results. The first is entitled "Seedlings of certain woody plants," in which numerous interesting facts are recorded, and the general conclusion reached "that broad generalizations in regard to the shape of cotyledons in plant families cannot be safely made without a considerable mass of data." The second paper, entitled "Comparative anatomy cf hypocotyl and epicotyl in woody plants," reaches the conclusion that "the two regions are, in their primary structure, essentially dissimilar." Eight double plates illustrate the two papers.— J. M. C.

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[4] Ber. d. deutsch. bot. Gesells. **17**: 64. 1899.

HEDWIG and Schwägrichen's type specimens from North America have been examined thoroughly and critically by M. Jules Cardot, who publishes, in the *Bulletin de l'Herbier Bossier* 7: 300. 1899, the first installment of his revision. One hundred and fifteen species have been investigated as fully as the frequent scantiness of the material would permit, of which sixty-one are discussed in this first section. Four plates provide important structural details which are wanting in the figures of Hedwig and Schwägrichen. The author remarks, by way of introduction, "I offer my work especially to my American *confrères*, who are engaged with so much zeal and talent in studying the bryological riches of their vast continent. I hope that they will receive it kindly, and I shall be amply repaid for my labor if they consider it of some utility." We may say that, without question, M. Cardot has made American bryologists his debtors, for the work is one that will be of great service to them and certainly merits their grateful thanks.—C. R. B.

MR. EDWARD C. JEFFREY[5] has been studying Equisetum and its allies, chiefly as to the development of tissues and organs. Two primitive types of stelar structure are distinguished, the single concentric strand and the tubular concentric strand. The former he calls protostelic, the more primitive type; the latter siphonostelic. The siphonostelic type has two modifications, which he calls phyllosiphonic and cladosiphonic. In the former case the continuity of the vascular cylinder is interrupted by lacunæ occurring above the points of exit of the leaf traces; in the latter case the lacunæ occur above the traces of the branches. Phyllosiphony is associated with large leaves, as in Filicales, cladosiphony with small leaves, as in Equisetales and Lycopodiales. In reference to the morphology of the vascular strands the author returns to the standpoint of Sachs and De Bary, as opposed to that of Van Tieghem modified by Strasburger.

He also finds that in the development of the archegonium there is no basal cell, as in the homosporous Filicales, and that the neck canal cell divides longitudinally, as reported by Treub for *Lycopodium phlegmaria*.

In tracing the development of the sporophyte embryo Mr. Jeffrey finds that both root and shoot arise from the epibasal region, a fact not at all in accord with the embryogeny of homosporous Filicales.

The conclusion is reached that the Equisetales are related to the Lycopodiales rather than to the Filicales, the points of resemblance and distinction being as follows: gametophyte with fleshy vertical axis and thin lateral lobes, archegonium with no basal cell and with vertical division of the neck canal cell, root and shoot epibasal in origin, small leaves and strobili, and cladosiphony.

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[5] The development, structure, and affinities of the genus Equisetum. Memoirs Boston Soc. Nat. Hist. 5: 155–190. *pls. 26–30.* 1899.

Fossil forms were also considered, and, applying the data mentioned above, it was concluded that the Sphenophyllum forms should not constitute a separate phylum, but that they belong to the Equisetum series, as primitive protostelic forms. Accordingly the phylum Equisetales, extending from the Silurian to the present time, is made to include three families, Sphenophyllaceæ, Calamitaceæ, and Equisetaceæ.—J. M. C.

M. W. BEIJERINCK[6] has made a valuable contribution to the subject of spore production in alcoholic yeasts. The method employed by him, which I have tried also and found successful, was as follows:

Two per cent. agar-agar was added to distilled water and boiled until thoroughly dissolved, then filtered and poured in a thin layer into a shallow glass dish. This is allowed to cool and solidify and is cut into thin strips, which are placed in a flask containing distilled water. The water is changed about once a week; in this way the agar is washed and purified and we obtain what Beijerinck terms "pure" agar. After the agar has been treated for a period of about six weeks, it is transferred into a clean flask and dissolved in the steam-bath, then placed in test tubes and sterilized in the usual manner.

The yeast is then spread in a very thin layer over the surface of slanted agar and the whole placed in the incubator at 28–30°C. or kept at the room temperature. Beijerinck obtained his best results by using room temperature, but I have obtained the best results with ordinary beer yeast at a temperature of 28–30°C.

Beijerinck also found that a sporogenous yeast cell multiplies by forming spores, and that if the cell begins to multiply by budding it cannot again be brought to produce spores.

In addition to the method for producing spores in yeast, Beijerinck in the second part of his paper gives some characteristics by means of which the sporogenous yeast cells can be distinguished microscopically from the asporogenous; they are as follows:

1. Spore-bearing cells can be differentiated from spore-free cells by means of the iodine reaction, inasmuch as in some cases the spores contain granules in the wall which stain blue, while the cell capsule remains colorless; in other cases the cell capsule contains glycogen and stains violet-brown by iodine, while the cell contents remain unstained (*S. Uvarum*), or finally the sporulation may be characterized through an accumulation of glycogen

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[6] BEIJERINCK, M. W.: Ueber Regeneration der Sporenbildung bei Alkoholhefen, wo diese Funktion im Verchwinden begriffen ist. Centr. f. Bakter. Parasit. u. Infek. **42**: 657–663, 721–730.

in the cell capsule and spores, which accordingly stain with iodine while the asporogenous cells are glycogen free (*S.* [*Mycoderma*] *orientalis*) and do not stain by iodine.

2. Spore-bearing colonies liquefy gelatin usually much faster than spore-free colonies.

3. Colonies with spores are often snow-white, while the spore-free colonies are colored watery-brown.— H. E. DAVIES.

THE KARYOKINETIC division of the nucleus of *Allium Cepa* has been further investigated by Němec.[7] In studying the formation of the achromatic spindle he finds that it does not begin as a multipolar affair, as found in other plants by Mottier, Osterhout, and others, but is bipolar from the beginning of its formation. Threads which appear just outside the nuclear membrane are soon seen to be drawn out into poles at opposite sides of the nucleus. The spindle fibers of either pole may be of unequal length, but all converge toward a common point. Some of the figures suggest that other interpreters might claim for them the condition of multipolarity. The nuclear membrane does not often disappear until the achromatic spindle is almost formed, and there is no evidence justifying the statement that it contributes to the formation of the spindle. The form of the spindle is determined by the dimensions of the dividing cell. The development of spindles in cells of the plerome shows characteristic differences from the same process in cells of the periblem.

At about the time the nuclear membrane disappears the chromatin thread breaks up into a few divisions, and these again break up forming the chromosomes. If the chromosomes are short they are placed parallel to the spindle threads, while if they are long there is no regularity in their position. Some spindle fibers pass directly from pole to pole, while others are attached to the chromosomes. The chromosomes split longitudinally, beginning at the looped end. After the pairs of chromosomes have divided somewhat, fibers are seen connecting them, and Němec states that these fibers are entirely different in structure from those which first formed the spindle. They are thicker, more granular, and stain more like chromatin than the earlier formed fibers. As to their function, he says any statement would at present be a mere guess, but suggests that, by exerting a push, they may assist the fibers which are pulling the chromosomes.

Structures which have been described by some other writers as centrosomes are represented in the drawings, but the author thinks they are nucleoli, and are finally enclosed within the nuclear membrane.

The statement is made that the chief morphological difference between the division of cells of vegetative tissue and those of sporogenous tissue consists in the fact that the spindle of division of the former is always bipolar, while that of the latter may be multipolar at the beginning, and may or may not become bipolar.

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[7] Ueber die karyokinetische Kerntheilung in der Wurzelspitze von *Allium cepa*. Jahrb. f. wiss. Bot. **33**: 313–336. 1899.

Throughout the paper few references are made to the work done by others along these same lines. While the work is very similar to (and in some cases a repetition of) that done by Schaffner on *Allium Cepa* and published by him in the latter part of last year, no reference is made to it.—OTIS W. CALDWELL.

THE RECENT note by Nawaschin[8] on the peculiar behavior of the male cells in *Lilium Martagon* has called out a more extended paper by Guignard[9] upon the same subject. The preliminary statements of Nawaschin are confirmed, and the presentation of good figures adds to the conclusiveness of the demonstration.

Of the two male nuclei, one fuses with that of the egg, while the other, probably the first one to leave the pollen tube, passes on to fuse with one of the polar nuclei. This union is generally with the upper polar, but if the lower one happens to be more conveniently situated the male nucleus will be attracted to it. Hence the process cannot be explained by the fact that the two equivalent male nuclei are attracted respectively by the oosphere nucleus and its sister, the upper polar. In either case the ultimate fusion of all three nuclei is recorded.

A case figured in which the male nucleus, coiled like a closely compressed letter S, lies in the angle between the fusing polars, is cited as presenting a condition which, with the less perfect technique of eight years ago, might have been taken for a pair of fusing centrosomes. Possibly some will not see clearly how such a body could be cut so as to show the *two* pairs of fusing centers on opposite sides of the polar nuclei, as they have been figured in the familiar "quadrille." The new figures leave us still in the dark upon this point.

The fusion nucleus, whether of oospore or endosperm, preserves the external marks of its dual or triple nature, even in prophase stages. Under such conditions as have been described, the increased number of chromosomes in endosperm nuclei may find an easy explanation.

The male nuclei are described as long and variously twisted bodies, many of them presenting appearances which, as noted by Nawaschin, suggest a possible motility. While they are devoid of cilia and cytoplasm, they nevertheless deserve to be called antherozoids.

It may be of interest to call attention to somewhat similar observations made by other botanists. Golinski[10] reports male cells in pollen grains and tubes of Triticum and other grasses, which "are not unlike the antherozoids of a fern or of Chara." His figures, however, are very unsatisfactory. Mottier[11] figures a coiled male nucleus closely applied to the female, in *Lilium Martagon.* Indications of a male nucleus fusing with the polars have been found in *Lilium Philadelphicum* by some students in the Hull Botanical Laboratory during this last year. The present writer has found elongated, and often spirally twisted male cells in the pollen of Silphium, the figures for which are soon to be published. It would seem, then, that such reminiscent forms of male cells are to be looked for almost anywhere, if they can be found in such widely separated groups as the Gramineæ, Liliaceæ, and Compositæ.—W. D. MERRELL.

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[8] Bot. Cent. **77**: 62. 1899.

[9] Sur les anthérozoïdes et la double copulation sexuelle chez les végétaux angiospermes. Comptes Rendus **128**: 1–8. Apr. 1899.

OVERTON'S STUDIES on color have been previously referred to in this journal.[12] His results have now been more fully published and furnish some interesting data.[13] The author noticed that a red coloration appeared in leaves of Hydrocharis grown in a sugar solution, and that the colors deepened as the solution became more concentrated by evaporation. Knowing also that alpine plants are more highly colored than plants in the lowlands and that low temperatures cause an increase of sugar at the expense of starch, Overton felt that it was worth while to make some experimental studies as to the connection between red cell sap and sugar.

Elaborate and varied experiments were made on Hydrocharis. In water cultures the colors were developed by increasing the light sufficiently or decreasing the heat, light and heat being opposing factors. Where the light and heat conditions were such as to produce no red coloration in water cultures, 2 per cent. invert sugar solutions induced colors within three days. Both old and new leaves are affected and the colors deepen day by day. Plants grown in sugar solutions bloom sooner than when grown in water. Experiments with various other sugars resulted similarly. The color stuff is mainly in the palisades and may be precipitated by coffein or antipyrin in a form resembling precipitates of tannin stuffs. Utricularia, Elodea, Trapa, and other water plants gave similar results. Experiments were also made on cut stems of Lilium, Ilex, and other land plants; colors were obtained in sugar solutions but not in water cultures.

The author concludes that the formation of red cell sap is closely connected, in most of the plants studied, with a rich content in sugar. Low temperatures, but considerably above the freezing point, induce red coloration. Alpine leaves are more highly colored than leaves from the lowlands because of low night temperatures and increased light intensity. The red coloration in many winter leaves is due to an increase of sugar at the expense of starch, a condition that is brought about by low temperatures. Cultivation in sugar solutions as a rule produced coloration only in those plants in which colored cell sap, when present, occurs in the mesophyll. Plants that have red sap in the epidermis failed to respond to sugar solutions. The reddening of many fruits and the deeper coloration of alpine flowers may be due to the change of starch to sugar.

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[10] Bot. Cent. **55**: 1–17, 65–72, 129–135. 1893.

[11] Jahrb. f. wiss. Bot. **31**: 125–158. 1898.

[12] BOT. GAZ. **27**: 229. 1899.

[13] Beobachtungen und Versuche über das Auftreten von rothem Zellsaft bei Pflanzen. Jahrb. f. wiss. Bot. **33**: 171–231. 1899.

Overton thinks that the red pigment is a glucoside or some nearly related compound. The cells which contain the colored cell sap often have tannins present, whereas in many plants that showed no coloration there is no tannin. The precipitates thrown down by coffein and antipyrin resemble those of the tannins, and the author concludes that one of the constituents of the red pigment is a tannic acid. The chemical nature of the pigment doubtless varies considerably in different plant groups.

The paper closes with a review of studies on red cell sap, giving great credit to the pioneer work of von Mohl. Wigand long ago associated the red color with tannins. Although Overton says little as to the ecological significance of red colors, he inclines to Stahl's view that they increase the available heat of the plant and thus favor nutrition. He thinks it possible that red colors may have been produced as an adaptation to unfavorable conditions by means of natural selection.— H. C. COWLES.

ITEMS OF TAXONOMIC interest are as follows: F. KRÄNZLIN has completed (Engler's *Bot. Jahrb.* **26**: 449–502. 1899) his account of Lehmann's Orchidaceæ from Central and South America, in this last fascicle describing about seventy-five new species and three new genera (*Otopetalum*, *Neolehmannia*, *Pterostemma*).—F. PAX (*ibid.* 503–508) has published Lehmann's South American Euphorbiaceæ, describing nine new species.—A. ENGLER (*ibid.* 509–572) has published his ninth installment of revisions of the genera of Araceæ, which contains *Philodendron* with 167 species, twenty-six of which are new, and *Dieffenbachia*, with eighteen species, one being new.— F. BUCHENAU discusses Ule's Brazilian Juncaceæ (*ibid.* 573–579), and also the genus Tropæolum (*ibid.* 580–588).— P. DIETEL and F. W. HEGER (*ibid.* **27**: 1–16. 1899) have published their third paper on Chilean Uredinaceæ, proposing *Mikronegeria* as a new genus.— R. PILGER (*ibid.* 17–36) in publishing Lehmann's and Stübel's South American Gramineæ describe numerous new species.—A. ENGLER'S studies of the African flora have reached the eighteenth number (*ibid.* 37–237), which contains the following contributions: G. LOPRIORE, on Amarantaceæ, in which twenty-two new species are described, a new genus *Sercostachys* proposed, and *Sericorema* and *Cypho-*

carpa, both heretofore sections of Sericocoma, raised to generic rank; W. RUHLAND on *Eriocaulon*, in which thirty-nine species are recognized, sixteen of which are new; R. SCHLECHTER on new and little known plants of his own collecting, being a second fascicle, and containing descriptions of 195 new species, one of which is the type of a new genus of Papaveraceæ, called *Trigonocapnos*.—W. A. SETCHELL (*Erythea* 7:45–55. 1899) continues his notes on Cyanophyceæ, describing two new species of *Scytonema* and one of *Nostoc*.—P. A. RYDBERG (*Bull. N. Y. Bot. Garden* 1:257–278. 1899) has published an account of the cespitose willows of arctic America and the Rocky mountains, including thirty-three species, ten of which are new.—J. K. SMALL (*ibid.* 278–290), in continuing his studies upon the flora of southern United States, has described seventeen new species in miscellaneous genera.—GEO. V. NASH (*ibid.* 290–294) has just described five new southern grasses.—M. L. FERNALD (*Proc. Am. Acad.* 34:485–503. 1899) has been studying *Eleocharis ovata* and *Scirpus Eriophorum*, and discovers considerable confusion and massing of forms. What has gone under the former name, a European species, proves to be for the most part distinctly American, and is *E. obtusa* Schultes. True *E. ovata* R. Br. also occurs at a few stations; while out of the plexus of forms three new species (*E. lanceolata*, *E. monticola*, *E. Macounii*) and four new varieties are disentangled, besides three already described species and one variety. In the case of *Scirpus Eriophorum* Mx. two new varieties are described, and a new species (*S. atrocinctus*) and variety separated.—L. M. UNDERWOOD (*Bull. Torr. Bot. Club* **26**:205–216. 1899), in his second paper on American ferns, discusses the genus *Phanerophlebia* Presl. which contains the form commonly called *Aspidium juglandifolium*, recognizing eight species, four of which are new.—E. P. BICKNELL (*ibid.* 217–231) has begun a study of *Sisyrinchium*, this first paper containing descriptions of sixteen new species from the southern states.—B. L. ROBINSON (*ibid.* 232–235) has published a revision of *Guardiola*, recognizing nine species, five of which are either new or are raised to specific rank.—AVEN NELSON (*ibid.* 236–250) continues his descriptions of new plants from Wyoming, the present fascicle containing twenty-two new species, two of which are included in a new genus (*Wyomingia*) founded on *Erigeron pulcherrimus* Heller.—J. M. C.

BEFORE THE Royal Society (London), Professor H. Marshall Ward recently read a paper upon *Onygena equina* Willd., a horn-destroying fungus. The following is an abstract by the author:

The genus *Onygena* comprises half a dozen species of fungi, all very imperfectly known, remarkable for their growth on feathers, hair, horn, hoofs, etc., on which their sporocarps appear as drumstick shaped bodies 5–10^{mm} high. A cow's horn, thoroughly infested with the mycelium of the present species, yielded material for the investigation, and the author has not only verified what little was known, but has been able to cultivate the fungus and trace its life history, neither of which had been done before, and to supply some details of its action on the horn.

The principal new points concern the development of the sporophores, which arise as domed or club-shaped masses of hyphæ and stand up into the air covered with a glistening white powder. Closer investigation shows this to consist of chlamydospores, formed at the free ends of the up-growing hyphæ. Their details of structure and development are fully described, and their spore nature proved by culture in hanging drops. The germination, growth into mycelia, and peculiar biology of these hitherto unknown spores were followed in detail, and in some cases new crops of chlamydospores obtained direct in the cultures.

When the crop of chlamydospores on the outside of the young sporophore is exhausted, the hyphæ which bore the spores fuse to form the peridium clothing the head of the sporocarp, and peculiar changes begin in the internal hyphæ below.

Minute tufts or knots of claw-like filaments spring from the hyphæ forming the main mass of the fungus, push their way in between the latter, and so find room in the mesh-like cavities. Here the closely segmented claws form asci—they are the ascogenous hyphæ—and the details of development of the asci, their nucleated contents, and the spores are determined. As the spores ripen, the asci, which are extremely evanescent, disappear, and in the ripe sporocarp only spores can be seen lying loose in the meshes of the gleba. The ascomycetous character of the fungus is thus put beyond question, though the peculiar behavior of the developing ascogenous tufts at one time rendered it questionable whether the older views as to the relationships were not more probable.

No one had hitherto been able to trace the germination of these ascospores—the only spores known previously—and De Bary expressly stated his failure to do it. The author finds that they require digesting in gastric juice, and so in nature they have to pass through the stomach of the animal. By using artificial gastric juice, and employing glue and other products of hydrolysis of horn, the details of germination and growth into mycelia, capable of infecting horn, were traced step by step under the microscope and fully described.

No trace of any morphological structure comparable to sexual organs could be discovered, though many points suggest the alliance of this fungus with Erysipheæ and truffles.

The author also found that similar digestion promotes the germination of the chlamydospores, and in both cases has not only traced the germination step by step, but has made measurements of the growth of the mycelium, induced the formation of chlamydospores on the mycelium again, and by transferring vigorous young mycelia to thin shavings of horn has observed the infection of the latter.

It thus becomes evident that the spores of *Onygena* pass through the body of an animal in nature, and, as might be expected from this, extract of the animal's dung affords a suitable food medium to re-start the growth on horn. Probably the cattle lick the *Onygena* spores from their own or each other's hides, hoofs, horns, etc., and this may explain why the fungus is so rarely observed on the living animal: it is recorded from such in at least one case, however.

Very little is known as to the constitution of horn, and some experiments have been made to try to determine what changes the fungus brings about. The research has also obvious bearings on the question of the decomposition of hair, horn, feathers, hoofs, etc., used as manure in agriculture. Although a bacterial decomposition of hoof substance is known to the author, special investigation of the question showed that in the present case no symbiosis between bacteria and the *Onygena* exists.

For the details as to the literature, the discussion as to the systematic position of *Onygena,* the experimental cultures, growth measures, and the histology, the reader is referred to the full paper, which is illustrated by plates and numerous drawings.— H. M. WARD.